



TYPE PG-23
PULSE GENERATOR

OPERATING
AND
SERVICE MANUAL

LYONS INSTRUMENTS



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PULSE GENERATOR

TYPE PG-23

SERIAL NUMBER 8039

LYONS INSTRUMENTS LTD.,
HODDESDON, HERTS, ENGLAND.

Telephone: Hoddesdon 67161 Telex: 22724

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INTRODUCTION

The Lyons Instruments type PG-23 is an all silicon solid state pulse generator providing rise and fall times better than 5 nanoseconds, repetition rates from 1 Hz to 10 MHz, single or double pulse (20 MHz effective single pulse rate), or square wave, and wide range control of pulse width (20 ns to 200 ms) and delay (-10 ns to +200 ms). Independent normal/complement facilities on each channel provide duty cycles up to 100%, and the output circuits are fully short-circuit protected. Each output is variable up to 10 volts into 50 ohms.

The input circuits of the PG-23 permit external drive from D.C. to 10 MHz, synchronous-start gating, manual one-shot operation, or synchronisation of the internal oscillator to frequency ratios as high as 100 to 1. On external drive the comprehensive slope, sensitivity and threshold controls enable triggering or gating to occur at a selected point on the trigger waveform. The sync. output is provided with a variable width control.

The PG-23 is a compact instrument, with panel height of only 3½", and can readily be rack mounted if required. High quality components are employed throughout, including silicon semiconductors and glass-epoxy printed boards.

This manual contains information on the operation, application and maintenance of the instrument. While we have attempted to make it as comprehensive as possible, our Engineering Department will be pleased to advise on any points relating to customers individual applications or requirements.

Lyons Instruments products are subject to a one year guarantee. Details of this are given in section six of this manual.

SECTION 1

SPECIFICATION

- 1.1. Pulse Amplitude: 10 volts into 50 ohms from simultaneous positive and negative outputs. Amplitude variable to 100 millivolts in four 10dB attenuator steps plus vernier control of 3 to 1 range. Both outputs are short circuit and open circuit protected. Duty cycle up to 100% obtainable.
- 1.2. Pulse Shape: Rise time less than 5nS
Fall time less than 5nS
Overshoot and ringing less than 5% of amplitude. (at 40dB setting less than= 7%).
- Note: 1.1 and 1.2 apply only when outputs terminated with 50 ohms via cable of that impedance.
- 1.3. Pulse Width: Variable from 20nS to 200mSec in seven ranges plus vernier control. Jitter less than 0.1% of value + 0.4nS.
- 1.4. Delay: Variable from -10nS to 200mSec with respect to the sync pulse output. Jitter less than 0.1% of value +0.4nS.
- 1.5. Sync Pulse: 2 volts positive into 50 ohms, at clock or external repetition rate. Width variable 15nS to 90nS. (These figures are typical).
- 1.6. Pulse Mode: 1.6.1. Normal: Output pulse width and delay controllable in conventional manner.

- 1.6.2. Complement: Outputs inverted but not shifted with respect to ground. The operation of width control reversed.
- 1.6.3. Single Pulse: One output pulse appearing at each output per repetition rate cycle.
- 1.6.4. Double Pulse: Output pulses occurring in pairs, one pulse at each output at a fixed delay with respect to the sync pulse (5nS) the second pulse variable in delay by means of Delay controls.
- 1.6.5. Square Wave: Output pulses at clock rate, symmetry adjustable $\pm 7\%$ giving square waves. Width and Delay circuits inoperative.
- 1.7. Repetition Rate: 1Hz to 10MHz in seven decade ranges plus vernier. 20MHz available in double pulse mode. Jitter typically less than .05% of value $\pm 0.4\text{nS}$.
- 1.8. External Input:
- 1.8.1. Sensitivity: 1V peak into high impedance (1K Ω 27pf, approx).
- 1.8.2. Threshold: +2V to -2V adjustable at the front panel.
- 1.8.3. Slope: Negative or Positive selectable at front panel.
- 1.8.4. Sync: Rate generator synchronised to external signals over a ratio up to 100:1. Pull in range typically 10% of set frequency.

- 1.8.5. Gate: Synchronous gating of the rate generator by means of external signals. Sensitivity etc., as 1.8.1. and 1.8.2.
- 1.8.6. External: input socket protected to $\pm 50V$ at 25% Duty cycle and 30V DC.
- 1.9. Power Requirements: 240 or 220V $\pm 10\%$ 50-60Hz 120 watts 115V or 400Hz operation available on special order.
- 1.10. Weight: 19 lbs.

SECTION 2

Description of Controls

- 2.1. WARNING Do not directly connect the outputs of the PG-23 to other outputs or voltage sources. Refer to para 4.6. for output mixing instructions.

Warranty: On receipt of the instrument please check for signs of mechanical damage in transit. Should such damage be evident refer to the warranty and servicing section of this manual (section 6) and contact Lyons Instruments Ltd., or their agent in your country immediately. Do not attempt to repair or return the instrument without first contacting us.

2.2. Controls and Connectors:

The controls of the PG-23 provide a large number of configurations in the use of the instrument. As with all variable pulse generators, it is possible to set the controls in a manner where the settings are not compatible with each other, for instance selecting too high a repetition rate for the set width and/or delay. Such settings must be avoided if proper results are to be obtained. A brief description of each control and its operation is given, followed by a functional verification section which is intended to help the user become familiar with the instrument.

2.3. Power Switch. POWER

The POWER Switch connects AC to the mains transformer primary when pushed upwards. The pilot lamp lights and the sound of the cooling fan should be heard.

2.4. FREQUENCY:

The rotary switch of this dual concentric control selects one of the seven repetition rate ranges. The vernier control provides continuously variable settings for all ranges. Fully clockwise rotation of this control sets the highest frequency per range and

overlap at each range setting is provided.

2.4.1. GATE/SYNC/EXT - SLOPE - THRESHOLD

The three position lever switch selects the mode of operation of the rate generator. the GATE position provides synchronous gating facilities by means of an external signal applied to the BNC socket marked EXT. In the SYNC position, the rate generator is synchronised to the external signal over a 100:1 range whilst in the EXT position the rate generator is inhibited permitting its replacement by an external source or enabling the user to obtain single pulse operation by means of the MANUAL button. The SLOPE control allows the selection of either the positive or negative going edge of an incoming signal^S and the input threshold level may be varied by preset T.

2.5. DELAY

The DELAY rotary switch selects one of seven ranges and the concentric vernier provides continuously variable control and overlap for each range. Clockwise rotation of the vernier control sets the minimum delay at each range.

2.6. WIDTH

The WIDTH rotary switch operates in the same way as the DELAY control, fully clockwise rotation of the vernier control sets the minimum pulse width on each range.

2.7. SP/DP/SQ.WAVE

2.7.1. This rotary switch selects one of three modes of operation of the PG-23. The SP position selects the single pulse mode where one output pulse occurs at each

Output for every clock period and the DELAY range has a negative minimum limit with respect to the sync pulse. WIDTH control operation remains unchanged.

2.7.2. The DP position selects the double pulse mode which allows an effective output pulse rate of 20 MHz to be obtained by producing two output pulses during every clock period, the first being coincident within 5nS with the trigger pulse, the time relation of the second to the trigger pulse being set by the DELAY control. The width of both pulses is variable by means of the WIDTH control.

2.7.3. In the SQ WAVE position, the width and delay controls are inoperative and the outputs are in the form of a Square Wave. Symmetry is adjustable at the front panel (SYM ADJ).

2.8. NORMAL/COMPLEMENT

These two toggle switches cause the pulses fed to the output stages to be inverted whilst retaining their ground reference. Thus in the Normal mode, operation of the WIDTH control is as described in 2.6. In the COMPLEMENT mode, the effect of the WIDTH Control is reversed, allowing very large duty cycles to be obtained at either output.

2.9. AMPLITUDE

These dual concentric controls allow the outputs to be continuously varied over a 40dB range when terminated in 50 ohms.

2.10. OUTPUT

The two BNC sockets provide the output connections of the instrument.

2.11. SYNC & SYNC WIDTH

This BNC outlet supplies the reference trigger pulse at the clock

rate (or external signal rate). The SYNC WIDTH control varies the width of the sync pulse, fully clockwise rotation giving minimum width.

SECTION 3

FUNCTIONAL VERIFICATION

- 3.1. WARNING: The instrument is intended for driving resistive loads at ground potential. If any other type of connection is contemplated, please refer to section 4 and so avoid possible damage to the output circuits.
- 3.2. The purpose of this section of the manual is to help the user during 'first time' operation of the instrument both in checking that no damage has occurred during transit and to help in becoming familiar with the action of the front panel controls. The equipment required for the checkout of the PG-23 is as follows:-

- 3.2.1. A General purpose Oscilloscope of vertical bandwidth greater than 15MHz, having double beam and external trigger facilities and having vertical signal delay.
- 3.2.2. Two 50 ohm co-axial terminations capable of 2W dissipation, 50 ohm co-axial termination capable of 1/2W dissipation.
- 3.2.3. 3 BNC-BNC cables.
2 BNC-T connectors.

3.3. Test connections and settings

- 3.3.1. Connect the OUTPUT sockets via 50 ohm cable to the 2W terminations and T connectors at the oscilloscope vertical inputs.
- 3.3.2. Connect SYNC OUT via 50 ohm cable and terminated T-connector to the external trigger socket of the oscilloscope.
- 3.3.3. Connect power cable to mains supply
 - Red - Live
 - Black - Neutral
 - Green - Earth

3.3.4. Set the instrument controls as follows:-

POWER	OFF
FREQUENCY	100K-1M
vernier	Clockwise
DELAY	0-0.2 μ S
vernier	Clockwise
WIDTH	0.2 - .02 μ S
vernier	Midway
GATE/SYNC/EXT	SYNC
SP/DP/SQ.WAVE	SP
NORMAL/COMPLEMENT	NORMAL
AMPLITUDES	10-0dB
verniers	Midway
SYNC WIDTH	Clockwise

Set the oscilloscope sweep speed to 0.1 μ S/cm and vertical sensitivity to 5V/Div on both channels, DC coupled. Centre both traces.

Proceed as follows:-

3.3.5. Pulse Output

Turn POWER switch on, checking for the sound of cooling fan and noting that red pilot lamp lights. Two rectangular pulses approximately 5V amplitude, coincident in time and opposite in polarity, approximately 100nSec wide appear on the screen. (The trigger controls of the oscilloscope may need adjustment).

Check AMPLITUDE control verniers, 10V maximum at both polarities, a minimum of 3V on the 0-10dB range.

Return AMPLITUDE verniers to midway positions and check attenuator steps. Return to top range.

Switch from NORMAL to COMPLEMENT on both channels and note both pulses are inverted but remain at the same polarities with respect to ground. Return to NORMAL mode.

Turn Pulse WIDTH vernier from one extreme to the other, note pulse width changes smoothly. Return vernier to midway position.

Turn DELAY vernier from one extreme to the other Note pulse moves from left to right. Return to original position (clockwise).

Turn FREQUENCY control anticlockwise and switch to 1-10MHz. Now turn FREQUENCY vernier clockwise until several pulses appear on the screen, one at each end.

3.3.6. Double Pulse Mode - Square Wave Mode

Switch to DP. Turn DELAY vernier anticlockwise until a second pulse appears after the first on the screen. Check that WIDTH vernier alters the width of all three pulses now on the screen. Now switch to SQ WAVE and adjust oscilloscope time base and FREQUENCY vernier until one complete cycle appears. Check symmetry control SYM allows you to vary the mark to space ratio $\pm 7\%$ of period. Return to SP mode.

3.3.7. Manual Operation

Reset the instrument controls as follows:-

GATE/SYNC/EXT	EXT
DELAY	0-0.2 μ S
vernier	clockwise

WIDTH	0.2 - 2mSec
vernier	midway
SLOPE	+VE
NORMAL/COMPLEMENT	NORMAL
SP/DP/SQ.WAVE	SP
AMPLITUDES	MAX.

Set oscilloscope time-base to 1mSec/cm and operate the MANUAL button. A single pulse will appear at each output whenever the MANUAL button is pressed.

Set SLOPE to negative, a single pulse will appear whenever the MANUAL button is released.

3.3.8. External Trigger

For the next test a square wave source of approx. 2V amplitude is required (such as the oscilloscope calibrator output). With the PG-23 controls set as previously, apply a 1KHz square wave of more than 1V peak amplitude to the input jack of the pulse generator. Connect the oscilloscope external trigger socket to the square wave source using a 'T' connector. Adjust the oscilloscope for a stable display.

A pulse will appear at each output of the pulse generator which will shift one half of a calibrator period when the SLOPE switch is operated.

3.3.9. Gated Operation

Retain the set up of 3.3.8. Set the instrument controls as follows:-

FREQUENCY	1-10KHz
vernier	clockwise
DELAY	0-0.2 μ S
vernier	clockwise
WIDTH	20-2 μ S
vernier	Anticlockwise
GATE/SYNC/EXT	GATE
SLOPE	+VE
SP/DP/SQ.WAVE	SP
SYNC WIDTH	CLOCKWISE
AMPLITUDES	0-10dB
verniers	midway
NORMAL/COMPLEMENT	NORMAL

Apply a 1KHz square wave of greater than 1V peak aplitude to the EXT input jack as in 3.3.8. A group of pulses will appear followed by a space. Group and space are interchangeable by the operation of the SLOPE switch.

Turn the selector to SYNC and note that pulses are continuous. Turn the EXT and note pulses are at the rate of external drive and that the FREQUENCY controls are inoperative.

SECTION 4

OPERATION

4.1. Idle Output

When only one output is being used, radiation from the other may cause ringing of the output in use. This can be conveniently avoided by reducing the amplitude of the idle output by means of its attenuator switch so that it is terminated by the impedance of the attenuator.

4.2. Output Termination

To get clean waveshapes with fast transition times, both the interconnecting cables and the load termination must have an impedance of 50 ohms. The termination should be placed at the far end of the cable rather than at the instrument end. Terminating at the pulse generator or using co-axial cable of the wrong characteristic impedance or using clip leads will have detrimental effects on pulse shape and transition times.

4.3. Nonlinear Loads

Operating directly into nonlinear devices such as transistors and diodes that exhibit varying impedances in opposite directions causes waveform distortion. This can be prevented by terminating the pulse generator in a network that reflects uniform loading in both directions. A suggested method of driving the base of a transistor is to provide a stand off resistor in series with the base, a bias return resistor and a termination, the three values being adjusted to provide a 50 ohm termination for the pulse generator.

4.4. Reactive Loads

Such loads connected directly to the output will cause pulse distortion. Inductive loads may damage the instrument. The instrument should be protected against inverse voltages generated by energy stored in an inductor or transformer. Diodes should be used to dampen the inverse swings and prevent the output transistors from being exposed to voltages above their inverse ratings.

4.5. Duty Cycle

If high duty cycles are required, use may be made of the COMPLEMENT facility of the instrument which reverses the effect of the width controls and allows the width circuits to operate at short recovery times.

4.6. Output Mixing

Same polarity outputs may be diode mixed and opposite polarity outputs may be resistor mixed, but units may not be directly coupled together nor connected to loads at other than ground potential. Pulse amplitude reduction is substantial for resistor mixing but negligible for diode mixing.

The loading circuit must protect outputs from same polarity voltages above the emitter base breakdown of the output transistors (5 volts) Diodes provide the best protection. Resistors may be used as voltage dividers but should be chosen so that each output is terminated in 50 ohms. Connections for mixing two outputs may be made by using one of the LI range of accessories.

SECTION 5

CIRCUIT DESCRIPTION

For ease of construction and maintenance the bulk of the electronic circuits of the PG-23 are mounted on four printed circuit cards, comprising respectively the rate generating circuit (card 23/1), width and delay circuits (23/2), output circuits (23/3) and power supply regulators (23/4).

5.1. Input Circuit and Rate Generator

The input and rate generating section (figure 7.3.) consists of a Schmitt trigger and free-running multivibrators which are used to provide the basic pulse or square waves required to drive the width/delay section. When the instrument is operated in its External mode, the input frequency fed via the Schmitt circuit determines the rate of operation of the generator. If the Gate or Sync mode is selected, the free-running multivibrator determines the repetition rate, which can be 'pulled' by an external input (if present) in the sync mode and 'interrupted' in the Gate mode. The rate generating circuitry is housed on card 23/1 and provides four outputs, comprising a square wave derived directly from the free-running multivibrator which is capable of symmetry adjustment, and three further outputs which are used to drive the width, delay and sync pulse generators on the following card. One of these outputs may be inhibited by operating Single/Double pulse selector switch so that the width generator on card 23/2 can be driven either once or twice during each clock period.

Referring to the circuit diagram of card 23/1 (fig 7.3) it can be seen that Q1 to Q3 form the external input Schmitt trigger, the input signals being applied to pin 1. D1 and D2 act as input protection clamps. The manual control push button operates into pin 2 and its position in the circuit gives the system a manual gate facility as well as single shot operation. Threshold may be adjusted between $\pm 2V$ and Sensitivity is fixed at greater than 1V peak.

Q4 and Q5 form the slope selection inverters and their outputs are routed via the selector to either the rate generator itself when SYNC or GATE modes are selected or to the output drivers when 'EXT' is selected.

Q6 and Q13 form the rate generator, Q9 and Q10 being variable current sources providing vernier control in the pulse mode and symmetry adjustment for square wave operation.

Q3 inhibits the clock either for the duration of a differentiated Schmitt trigger output during Sync operation, or for the duration of the gating waveform when the Gate mode of operation is selected. Q11 is a 'kicker' which monitors both phases of the rate generator and ensures clock starting under all conditions.

Q14 is an output driver which is selected during square wave operation of the instrument.

Q15 and Q16 form an OR function, accepting either the rate generator signals or the external signals via the Schmitt and selector switch into pin 23. The output of the OR Gate drives the three current sources providing outputs to the next card of which Q17 can be inhibited for single pulse operation.

5.2. Width Delay Generator

The Pulse Width, Delay and Sync output is housed on card 23/2 section (Fig 7.5.) and contains three monostable multivibrators. The first of these forms the delay generator which is triggered once per clock period, an output being derived from the back edge of its output waveform, which in turn triggers the width generator in the single pulse mode. During double pulse operation, the width generator accepts a second trigger per period derived directly from the rate generator (Q17) and which is not delayed so that two pulses for each clock period appear at the output of the width monostable.

The third monostable circuit is the sync pulse generator which gives an output of variable width into 50 ohms. During Single

pulse operation the input of the Sync pulse generator is delayed by 90nS by means of a fixed delay line enabling the output pulse delay to be set negative with respect to the Sync pulse output. During double pulse operation the delay line is switched out so that the first pulse of each pair is coincident within 5nS of the Sync pulse output. The three monostable circuits are similar. Referring to circuit 23/2 it can be seen that Q1 and Q2 form a fast trigger generator, producing pulses of 5V amplitude and some 15nS duration. The trigger pulses are applied to emitter follower Q5 and via the timing capacitor C7 to Q4. This stage turns off and variable current source Q3 produces a linear discharge of the timing capacitor, providing vernier control. Q6 provides the inversion necessary to complete the loop and the output of the monostable appears at its collector. Q7 inverts the pulse and shapes it to drive the fast trigger generator Q3, Q9. During double pulse operation an identical trigger circuit Q17 Q13 receives inputs from the rate Generator card the two triggers being mixed at the collectors of Q11 and Q9 and fed to the width generator Q12 to Q15; which is identical to the delay generator described above. The output of Q15 drives the grounded base amplifier Q16 used to provide output signals to the next card via pin 13.

The Sync pulse generator consists of the standard trigger circuit Q17, Q13 followed by a single range variable monostable Q19 to Q21 providing sync pulse width variation. C24 is the timing capacitor and varying voltage applied via pin 15 to R46 completes the rest of the timing elements.

Q22 is an emitter follower driving the panel mounting co-axial connector via pin 16 providing the sync pulse output.

5.3. Output Stage

The output circuitry of the PG-23 (Fig 7.7) consists of two channels which are mirror images in terms of semiconductor types. After normal/complement switching the pulse undergoes further stages of level shifting and amplification until

sufficient swing is available to obtain the required 10V in 50 ohms. In the positive output channel Q1, Q2 form a current pair and Q3, Q4 are a pair of grounded base stages. Normal/Complement switching is carried out by inhibiting either Q3 or Q4 by means of 12V applied to P1 or P2. The output of Q3 or Q4 is level shifted by Q5 Q6 and amplified by Q7 Q8, which then drive the final output switch Q9 Q10. This has a collector supply set at two diode drops below the +16V line, ensuring that when Q10 is off sufficient headroom is left for the emitter follower stages which drive the output termination.

The negative pulse channel is very similar and from Q20 onwards is a mirror image of the positive channel.

Output stage short circuit protection is provided by resistors in the collectors of the output emitter followers which ensure saturation when the output is shorted, and by making the $\pm 16V$ supplies go into a constant current mode when a short is applied.

Open circuit protection is inherent in the reverse Vbe of the output devices and the attenuator values.

The outputs from the positive and negative channels (pins 5 and 8) one taken to passive attenuators comprising for 10dB steps and a continuously variable vernier attenuator at 3:1 range, and thence to the BNC output connectors.

As can be seen, the source impedance is not 50 ohms and the instrument relies on good output termination for a clean pulse waveform.

5.4. Power Supplies

The power supply consists of a mains transformer followed by full wave diode bridge rectifiers driving reservoir capacitors and regulator amplifiers. The low current power supply components are mounted on printed circuit card 23/4, the series transistors are on a heatsink which is in the cooling fan airflow. The printed circuit board is hinged and can be

swung out for ease of measurement and servicing and the power supply outputs are accessible on the emitter pins of the power transistors.

The power supplies are protected against accidental short circuit and care has been taken to ensure reliable operation at high ambient temperatures. From circuit diagram 23/4 (Fig 7.9) it can be seen that Q1 is the series element for the -7V line which is referenced by means of Zener D5. The -16V line uses D3 as reference, Q4 being the voltage amplifier and Q3 and Q5 supply the output current. Q2 with associated components is a current source ensuring high gain of amplifier Q4 and R5 is an output current sensor which together with D6, D7 determine the point at which the supply becomes a constant current source.

The other supplies are very similar, differing mainly in polarities of voltage supplied. Care is taken to ensure self protection of the power supplies by ensuring saturation of the $\pm 7V$ Series elements and by allowing the $\pm 16V$ lines to run into a constant current mode when excess current is drawn. This also limits the amount of current supplied to the output stages which are fairly symmetrically connected between the supplies, making it easy to provide versions of the instrument giving either dual positive or dual negative output pulses.

SECTION 6
MAINTENANCE

6.1. Warranty

Lyons Instruments Limited guarantees each instrument manufactured by us to be free from defects in material and workmanship for a period of one year from date of delivery to the original purchaser. Repair during this time will be made by us free of charge if the instrument is returned to our works carriage paid.

Excluded from this guarantee are valve replacements, as well as all damages caused by, or related to, abuse of the instrument either electrically or mechanically. In this case repairs will be charged at cost and an estimate will be submitted for approval before the work is started. Transistor replacement if required, is normally included in the terms of the guarantee.

If an instrument is believed to be defective, please notify our Service Department, giving the model and serial number of the instrument, as well as a description of the nature of the fault. Our Service Department will then, if necessary, authorise the return of the instrument under the terms of this guarantee and advise how shipment should be made.

6.1.1. Claim for damage in shipment

If, on receipt, the shipping cartons show evidence of rough treatment, entry should be made on the carrier's delivery receipt indicating this condition.

As each instrument is unpacked, it should be inspected to ascertain that no damage has occurred during shipment. If no damage is visible, operational

checks should be performed to make sure that the instrument is in its original operating condition. If any damage is revealed, a claim should be filed immediately with the carrier, stating the extent of the damage. A copy of this report should be forwarded to Lyons Instruments together with the model and serial number of the instrument. We will then advise how the instrument should be returned for repair or replacement.

6.1.2. Shipping instructions for returning instruments under Guarantee

No instrument should be returned to the factory without prior authorisation from Lyons Instruments Limited.

Shipping instructions will be given at the time return of an instrument is authorised. In all cases the instrument should be packed in a strong container and surrounded by adequate shock-absorbing material.

Transit insurance covering the instruments being returned to Lyons Instruments should be effected by the sender.

6.2. Routine Maintenance

The PG-23 is fan cooled and when used in dusty environments the side filter plates should be removed (4 retaining screws) at 6 monthly intervals and washed in detergent. Replace when dry. In very hot conditions, the fan motor may require oil at 12 monthly intervals, remove instrument top cover and place no more than two drops of light oil onto the top bearing inner sponge.

6.3. Calibration

The PG-23 has been designed to have a minimum of internal adjustments. The frequency, width and delay controls have ranges considerably in excess of the 10 to 1 requirements and therefore there is no need for upper and lower limit range settings. The remaining potentiometers are concerned with power supply settings and output stage 'on' currents and should require adjustment at twelve monthly intervals or after any necessary repair work. Details of the adjustments are as follows:-

6.3.1. Power Supplies

Set controls to COMPLEMENT on both channels and select EXT on the lever switch. Terminate both outputs in 50 ohms at maximum amplitude and monitor the outputs of the power supplies. This can be done on the heat sink measuring at the emitter pins of the Series stabilizers.

The levels are as follows, measured relative to chassis.

YELLOW	+16V Adjust (RV2 on 23/4) to $\pm 3\%$ (AV08) Ripple 3mV p-p	
BLUE	-16V Adjust (RV1 on 23/4) to $\pm 3\%$ (AV08) Ripple 3mV p-p	
RED	+12.5V $\pm 0.5V$	Ripple 2mV p-p
GREEN	-7V $\pm 0.5V$	Ripple 5mV p-p
ORANGE	+7V $\pm 0.5V$	Ripple 5mV p-p

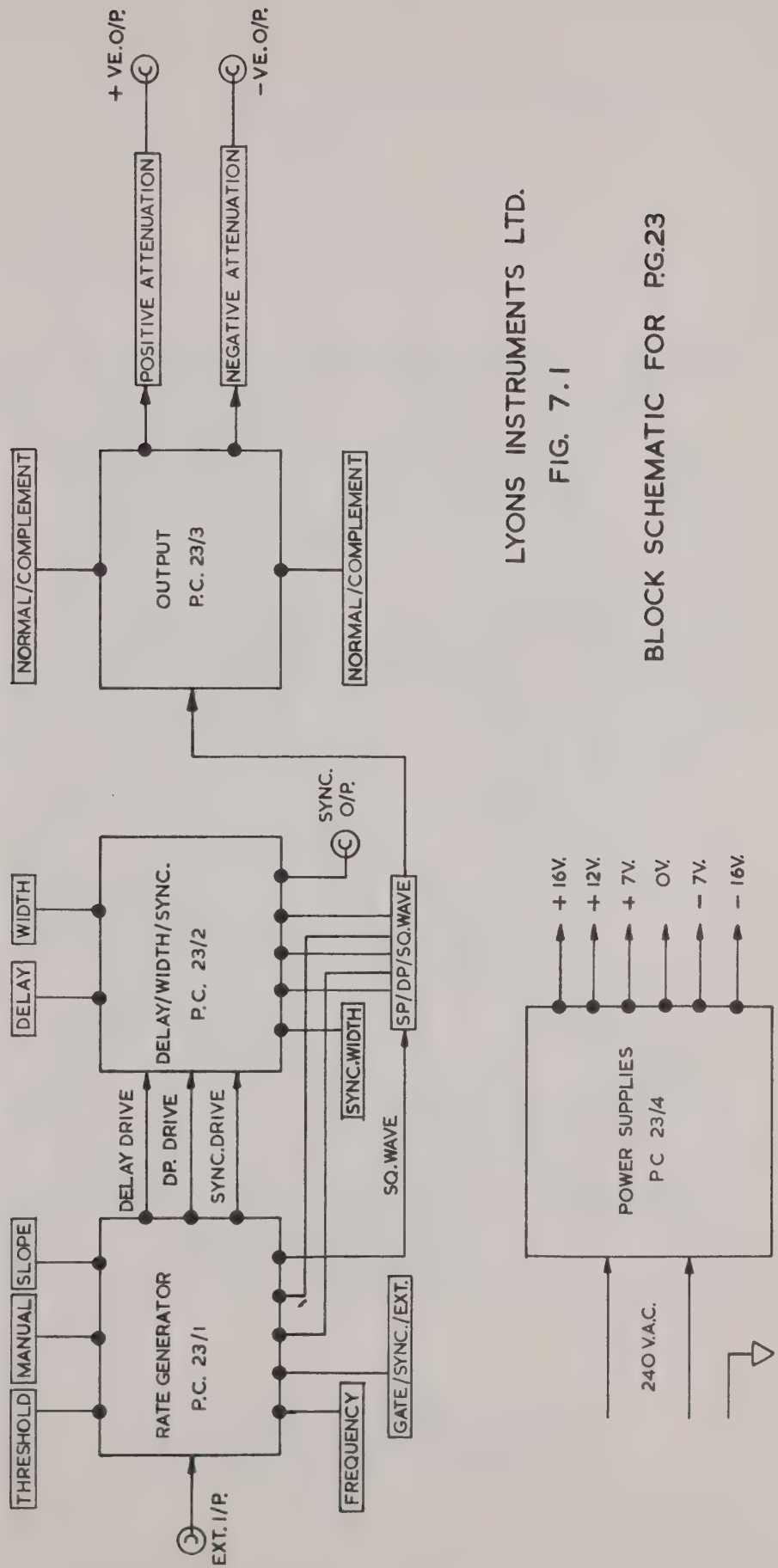
Note: on earlier instruments RV1 and RV2 were not included and the power supplies were adjusted on test. The first two adjustments need not therefore be carried out.

6.3.2. Output Stage

Set controls to NORMAL, select EXT on the lever switch. Measure at the collector of Q10 on 23/3 Adjust RV1 on 23/3 to between -1 and -2V (must not be more positive than -1V). Measure at the collector of Q25 on 23/3. Set RV2 on that board for collector level of +1 to +2V (must not be more negative than +1V).

N.B. These adjustments should not normally be attempted unless specific problems exist in either the power supplies or the output circuits of the PG-23.

Should you run into difficulty remember that the Engineering Staff of L.I. are always willing to help you.



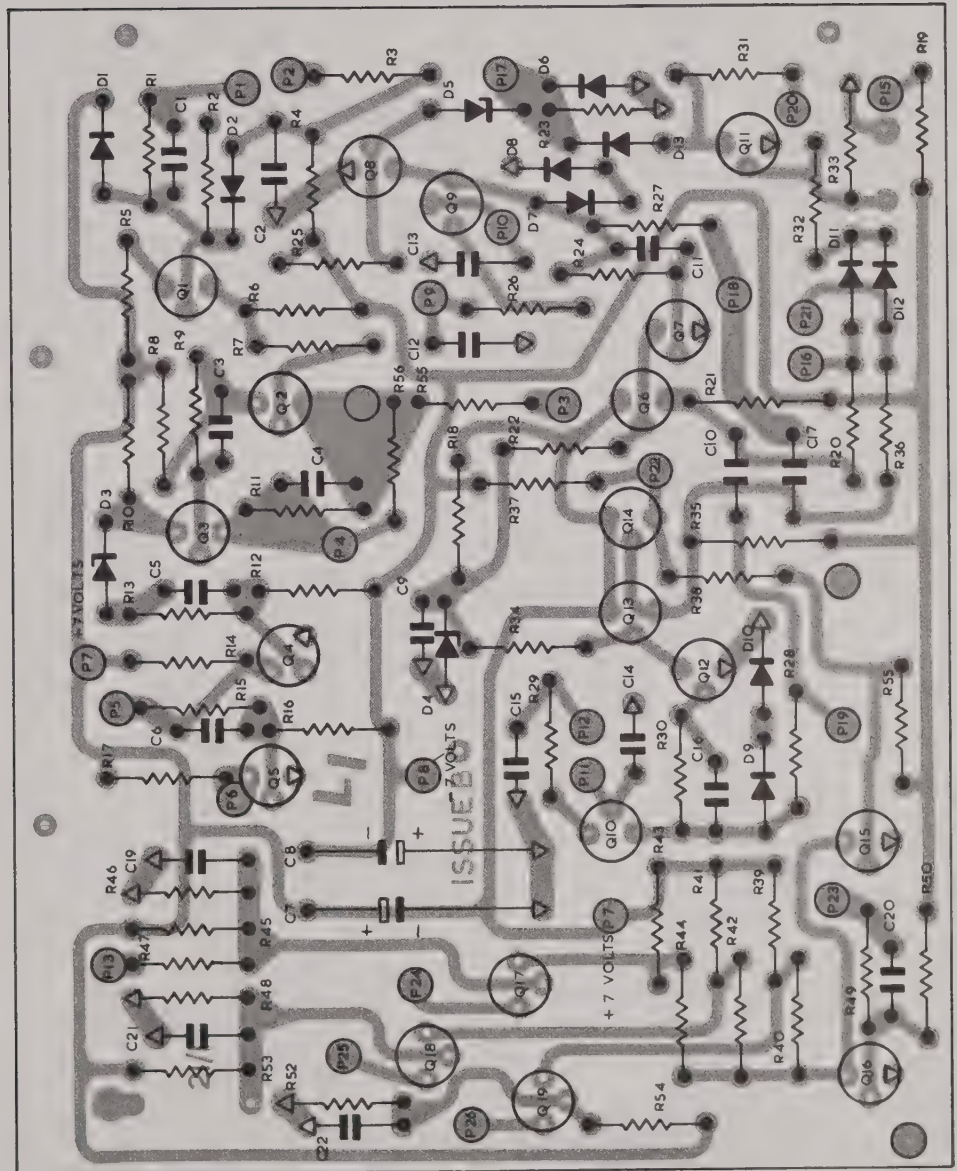
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FIG. 7.1

BLOCK SCHEMATIC FOR PG.23

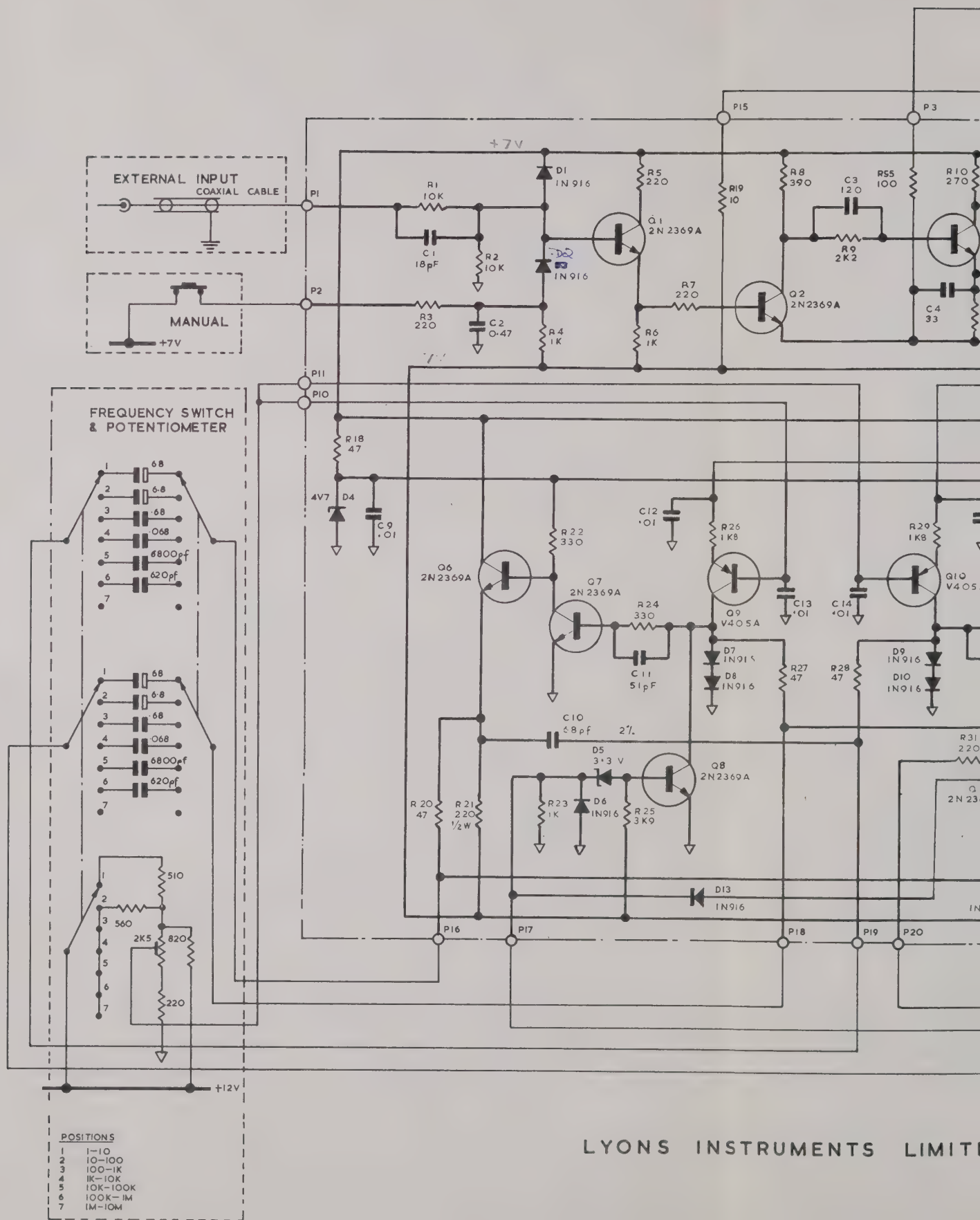
LYONS INSTRUMENTS LIMITED

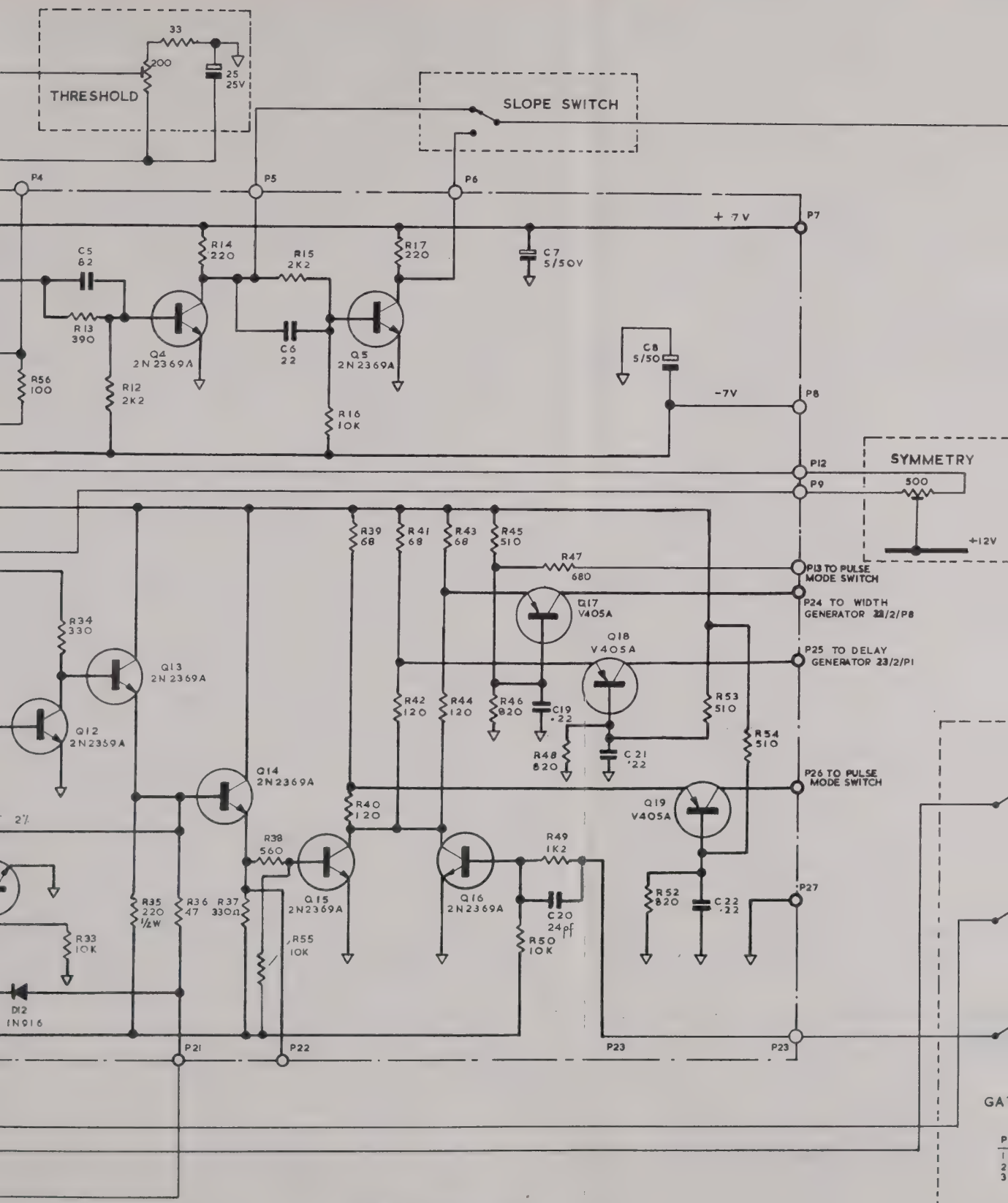
FIG. 7.2



23/1 PRINTED CIRCUIT BOARD
COMPONENT LAYOUT VIEWED
ON COMPONENT SIDE (B)

TRACK

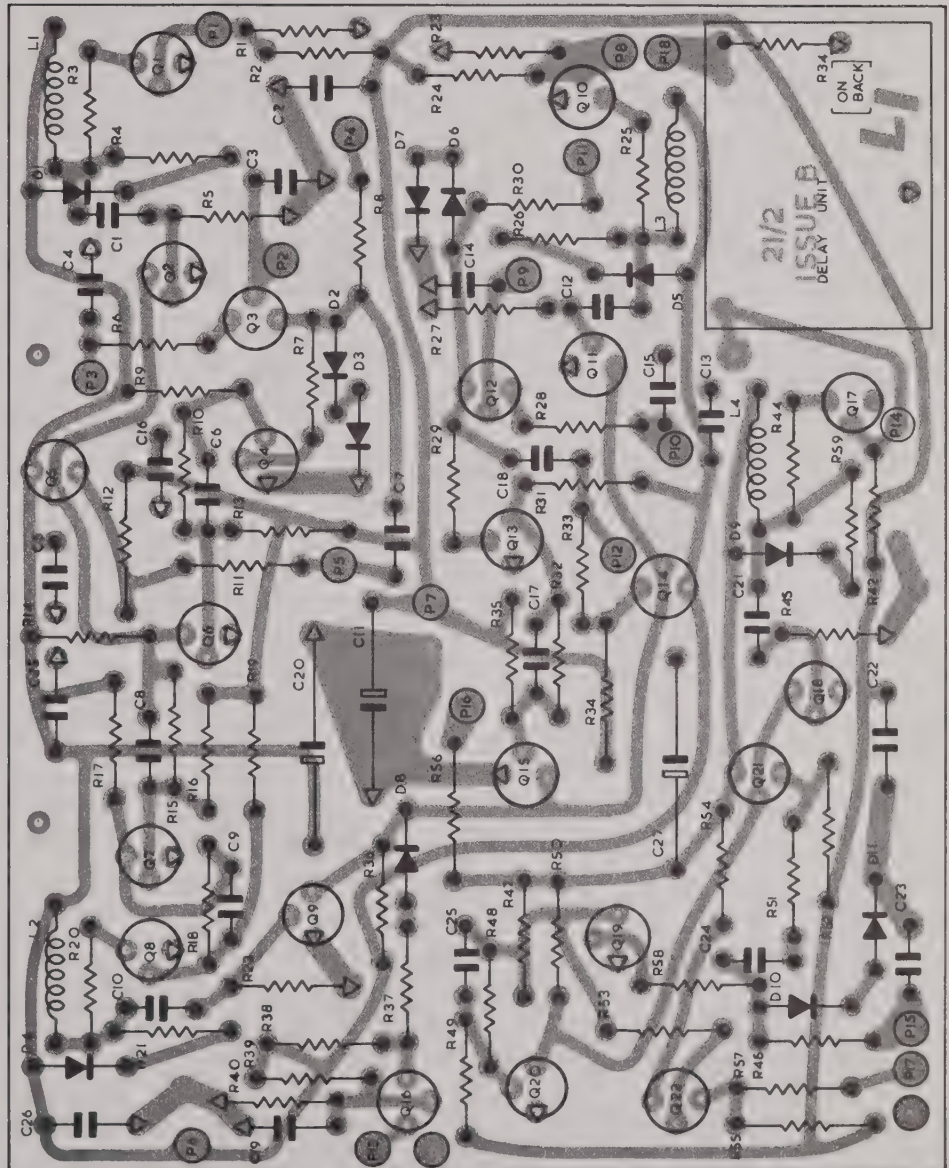




NOTES
UNLESS OTHERWISE STATED
ALL RESISTOR VALUES IN OHMS & ARE $\frac{1}{4}$ WATT
ALL CAPACITOR VALUES IN MFD.

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FIG. 7.4



23/2 PRINTED CIRCUIT BOARD
COMPONENT ASSEMBLY VIEWED
ON COPPER TRACK SIDE (B)

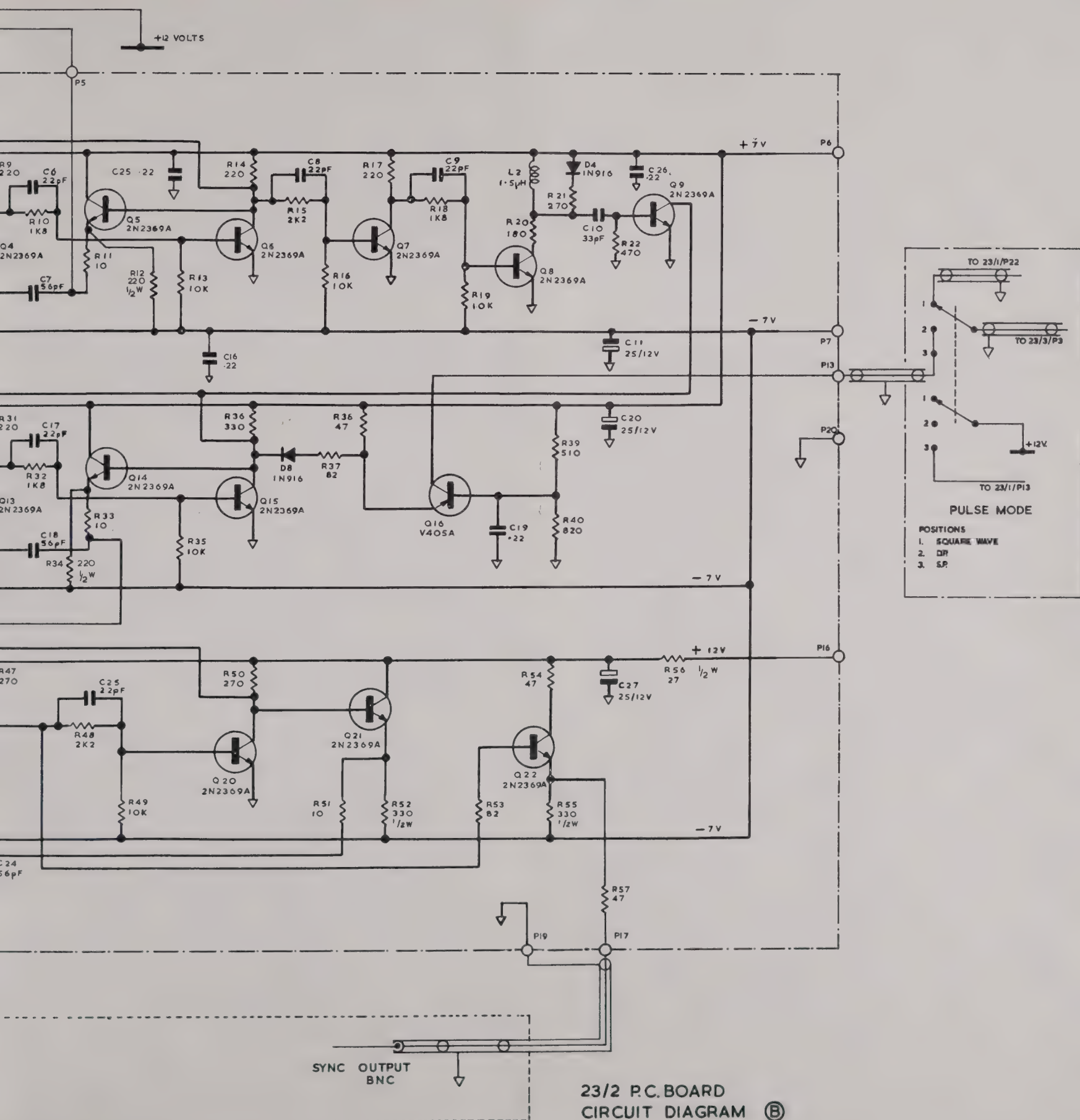
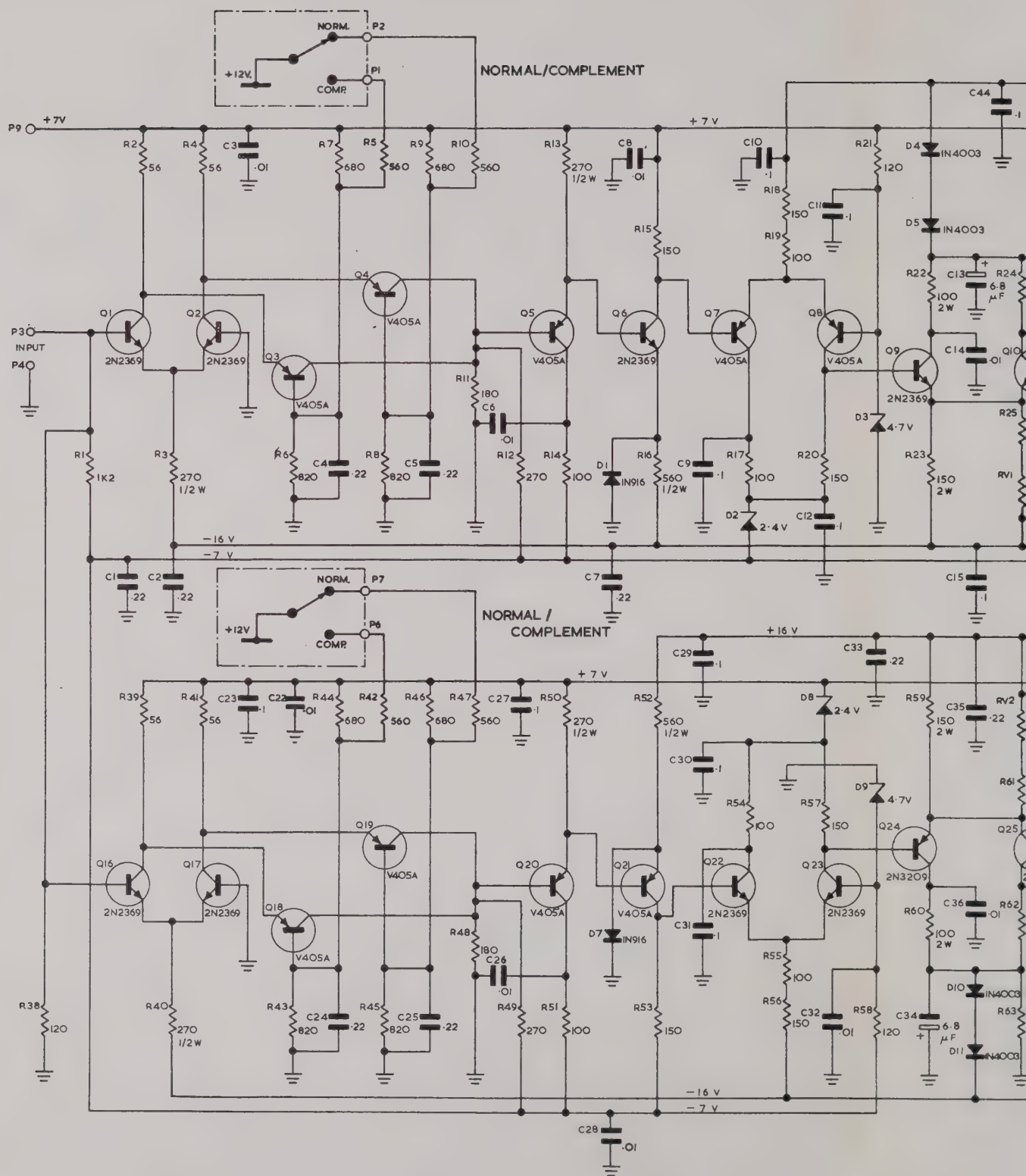
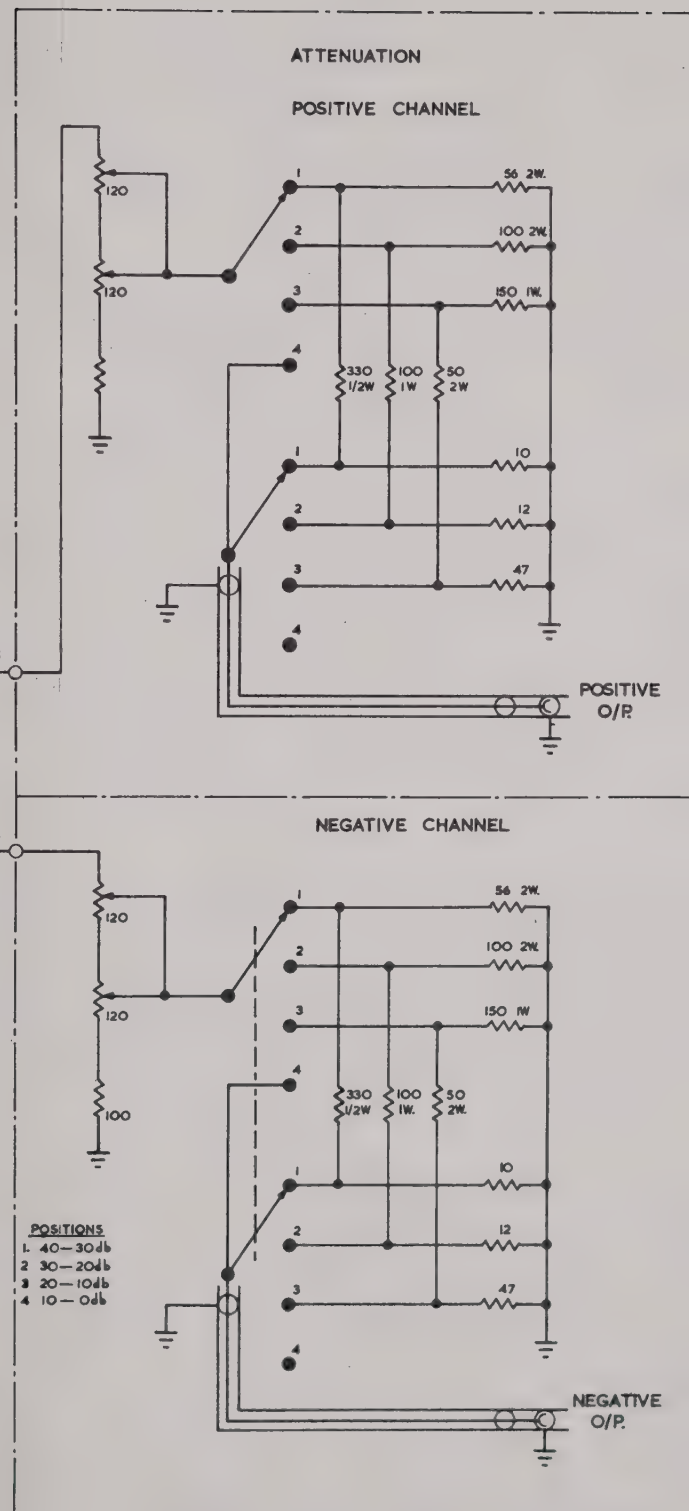
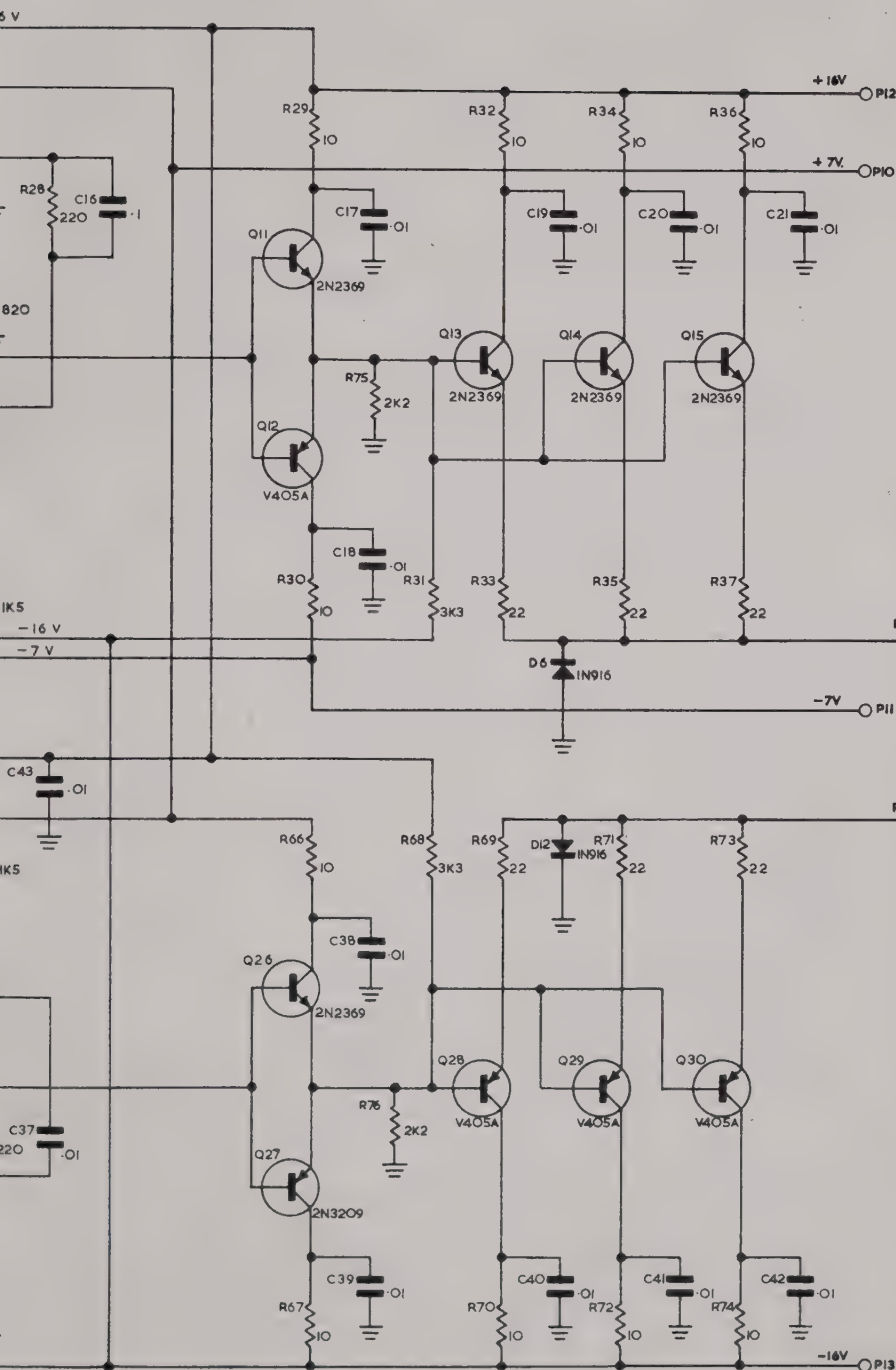


FIG. 7.6







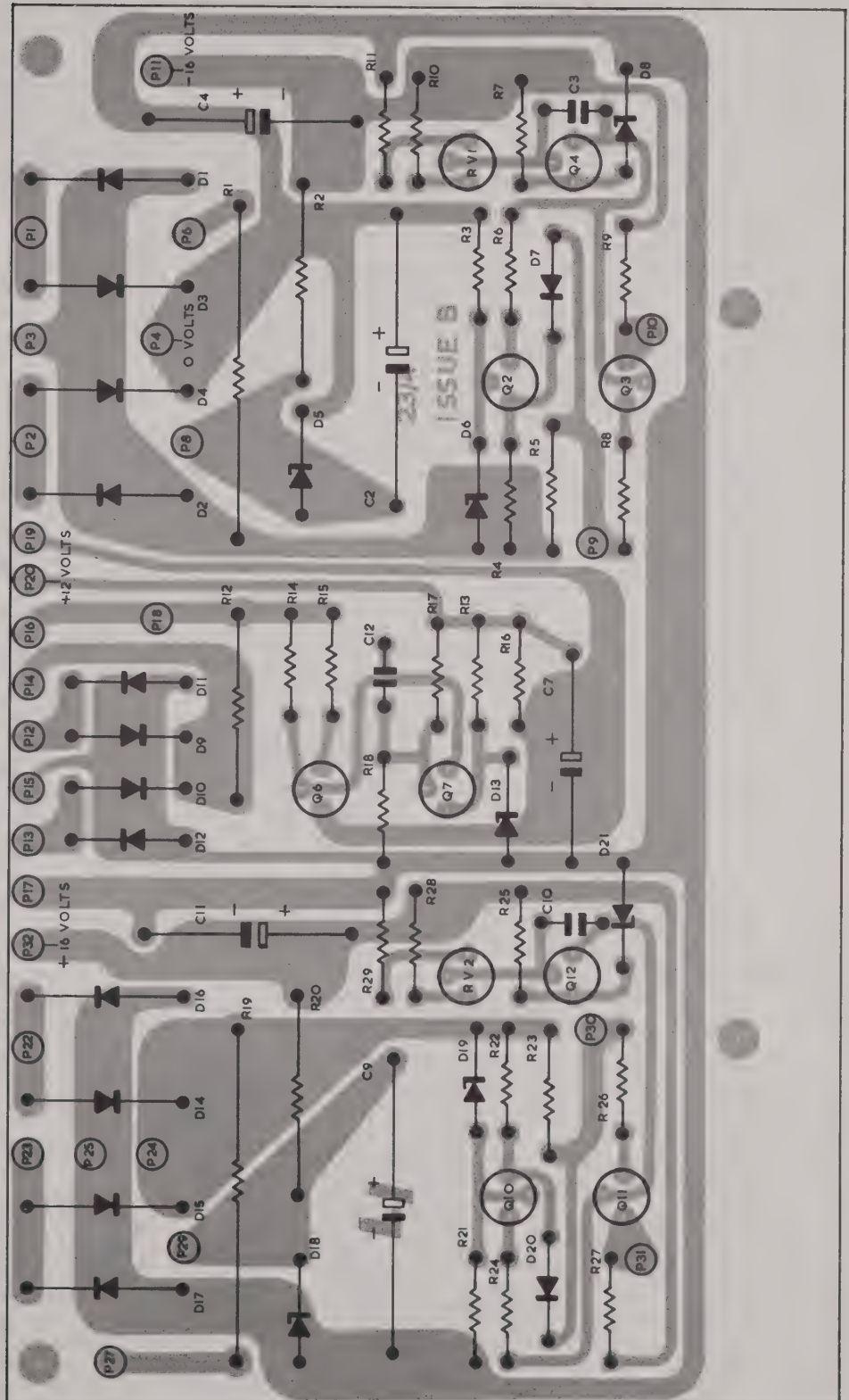
UMENTS LTD.

NOTES.
UNLESS STATED OTHERWISE:-
ALL RESISTOR VALUES IN OHMS AT 1/4W.
ALL CAPACITOR VALUES IN MFD.
ALL CIRCUITRY WITHIN DOTTED LINES
NOT ON P.C BOARD.

23/3 P.C. BOARD CIRCUIT DIAGRAM

FIG. 7-7

FIG. 7.8



23/4 PRINTED CIRCUIT BOARD
COMPONENT LAYOUT VIEWED
ON COPPER TRACK SIDE (B)

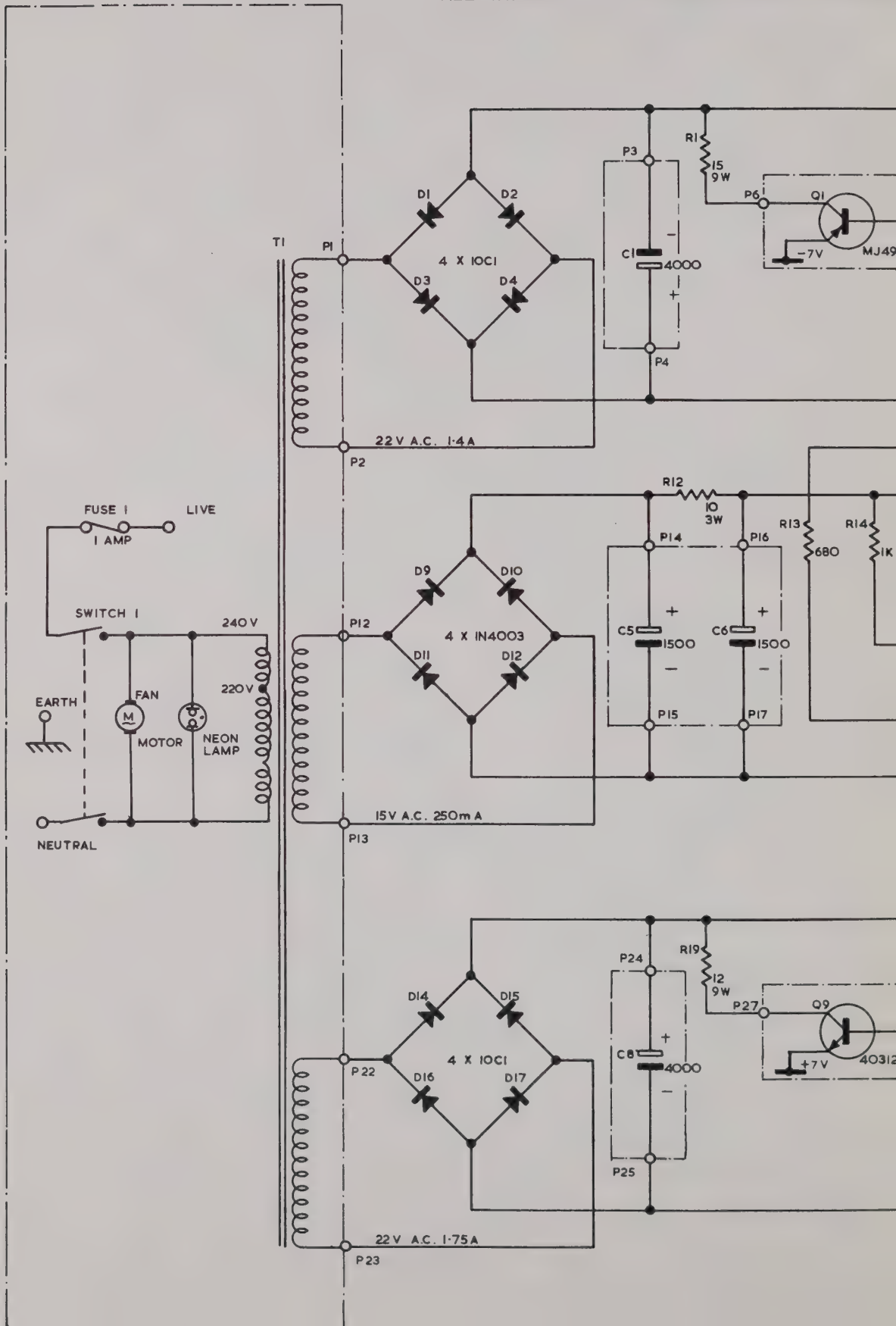
NOTES

RESISTORS

ALL VALUES IN OHMS UNLESS STATED OTHERWISE

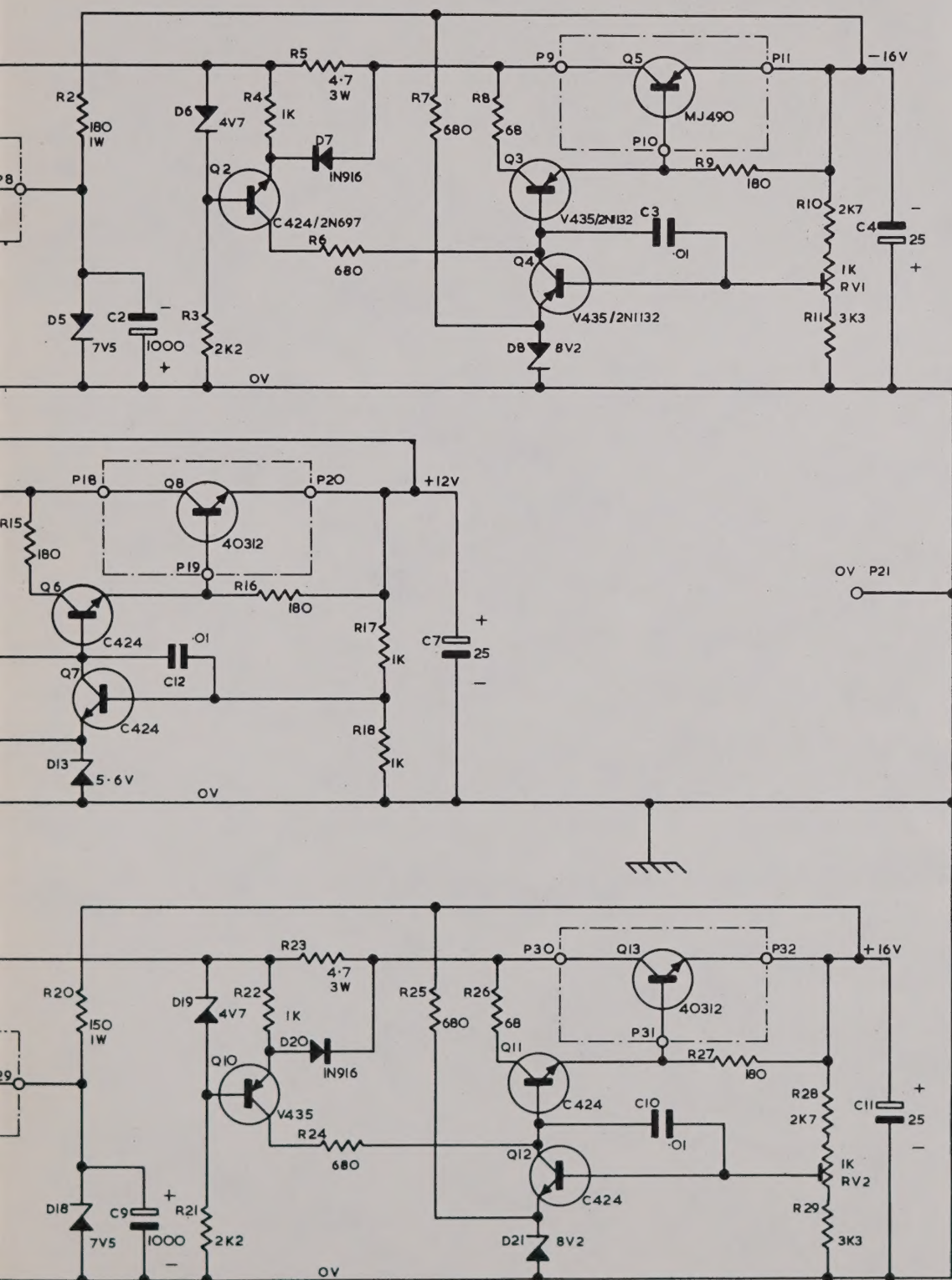
CAPACITORS

ALL VALUES IN MFD. UNLESS STATED OTHERWISE



WISE

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P.C. BOARD 23/4 CIRCUIT

FIG. 7.9

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